

Notice of Allowability

Application No.

10/692,020

Examiner

Kandasamy Thangavelu

Applicant(s)

BILLINGHURST ET AL.

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 26 January 2007.
2. ☒ The allowed claim(s) is/are 2-5, 7-19, 27-29 and 32-35.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
 5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached:
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413),
Paper No./Mail Date _____
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☒ Other Clean copy of allowed claims.

DETAILED ACTION

Introduction

1. This communication is in response to the Applicants' communication dated January 26, 2007. Claims 1, 20-26, 30 and 31 were canceled. Claims 2-13, 16-19 and 27-29 were amended. Claims 32-35 were added. Claims 2-19, 27-29 and 32-35 of the application are pending.

Color Drawings

2. The petition to Approve color drawings dated November 2, 2004 has been approved.

Examiner's Amendment

3. Authorization for this examiner's amendment was given in a telephone conversation by Mr. Steven Lawrenz on April 11, 2007.

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to the applicants, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

4. In the specification:

Page 10, Para 0044, Line 4, "the feature points to be extract from"

has been changed to

-- the feature points to be extracted from --.

Page 17, Para 0067, Lines 2-3, "The graph 800 is encoded using a key 810"

has been changed to

-- The graph 800 is encoded using a key 801 --.

5. In the claims:

Cancel claim 6.

Replace claims 8-11 with:

8. A method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

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receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

9. A method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of uniqueness of each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

10. The method of claim 11 wherein the selection of visual features is performed based upon a comparison of levels of accuracy with which they can be used to determine the location and the orientation of the surface.

11. A method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

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from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera,

wherein the selection of visual features includes selecting visual features in at least two different size ranges, the method further comprising selecting one of the size ranges based upon a measure of a distance to the surface's present location, and

wherein the selected features in the selected size range are used to determine the location and the orientation of the surface;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

Amended claim 13, Line 5, "fiducial markers to determining"

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has been changed to

-- fiducial markers for determining --.

Replace claim 16 with:

16. The method of claim 9 wherein the 3-dimensional location and orientation of the surface in the image of the sequence is determined without use of explicit fiducial markers.

Replace claims 18-19 with:

18. The method of claim 9 wherein the movement of the surface is tracked within an environment, and wherein, between two successive images of the sequence, the camera moves relative to the environment.

19. The method of claim 9 wherein the movement of the surface is tracked within an environment, and wherein, between two successive images of the sequence, the surface moves relative to the environment.

Replace claim 28 with:

28. A method in a computing system for determining 3-dimensional location and orientation of a subject surface in a distinguished perspective image of the subject surface, the subject surface having innate visual features, comprising:

identifying a plurality of subsets of innate visual features of the subject surface, each subset containing visual features of a different general size;

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based on an earlier-determined 3-dimensional location of the subject surface, selecting one subset of visual features;

using locations of the visual features of the selected subset in a perspective image of the subject surface that precedes the distinguished perspective image in time, and identifying search zones in the distinguished perspective image;

searching the identified search zones for the visual features of the selected subset to determine 2-dimensional positions at which the visual features of the selected subset occur;

based on the determined 2-dimensional positions, determining the 3-dimensional location and orientation of a subject surface in the distinguished perspective image;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

Replace claims 32-35 with:

32. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, the method comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

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from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

33. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, the method comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of uniqueness of each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

34. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, the method comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera,

wherein the selection of visual features includes selecting visual features in at least two different size ranges, the method further comprising selecting one of the size ranges based upon a measure of a distance to the surface's present location, and

wherein the selected features in the selected size range are used to determine the location and the orientation of the surface;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

35. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for determining 3-dimensional location and orientation of a subject surface in a distinguished perspective image of the subject surface, the subject surface having innate visual features, comprising:

identifying a plurality of subsets of innate visual features of the subject surface, each subset containing visual features of a different general size;

based on an earlier-determined 3-dimensional location of the subject surface, selecting one subset of visual features;

using locations of the visual features of the selected subset in a perspective image of the subject surface that precedes the distinguished perspective image in time, and identifying search zones in the distinguished perspective image;

searching the identified search zones for the visual features of the selected subset to determine 2-dimensional positions at which the visual features of the selected subset occur;

based on the determined 2-dimensional positions, determining the 3-dimensional location and orientation of a subject surface in the distinguished perspective image;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

A clean copy of allowed claims is attached.

Reasons for Allowance

6. Claims 2-5, 7-19, 27-29 and 32-35 of the application are allowed over prior art of record.

7. The following is an Examiner's statement of reasons for the indication of allowable subject matter:

The closest prior art of record shows:

(1) machine vision systems for tracking the movement of multiple objects within a predetermined area or volume; the systems are capable of creating three-dimensional tracking information using a system of markers placed upon the objects to be tracked; the markers are followed by an overlapping configuration of tracking cameras; as the image information is analyzed from the camera's two-dimensional view, it is combined to create 3D coordinates of each marker as the marker moves about in the designated tracking volume; based on the detected marker 3D locations and the pre-known relationship between the markers and objects, the system is able to re-assemble any given object's movement (**Aman et al.**, U.S. Patent Application 2003/0095186);

(2) method and apparatus for generating representations of objects in the three-dimensional computer model using moving pictures such as video images; image data from

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cameras having different views of objects in the scene is processed to determine whether image data identified for an object is associated with more than one object; a three-dimensional computer model is rendered for a chosen viewing direction; image data for an object in the scene is processed to produce a three dimensional model of the object in dependence upon surface planes of the object identified from the image data; image data from at least two cameras having different views of an object is processed to identify planar surfaces of the object on which feature points lie and to represent the object in three-dimensional manner in dependence upon the identified planes; a three-dimensional computer model is rendered for the chosen viewing direction and information indicating the accuracy of the model generated (**Rowe et al.**, U. S. Patent 6,914,599); and

(3) a vision based mixed reality system using natural feature points contained in images captured by a pair of stereo cameras in conjunction with pre-defined fixed fiducial markers; the system first uses pre-defined fiducial markers to estimate a projection matrix between real and virtual coordinate systems; at the same time, the system picks up and tracks a set of natural feature points from the initial image; as the user moves around in the MR environment, the initial markers fall out of the camera frame and the natural features are then used to recover a projection matrix; augmented reality produces an environment in which virtual objects are superimposed on user's view of the real environment; virtual objects should be superimposed on the right place as if they really exist in the real world; the method estimates the position and orientation of user's view point from images captured by the cameras (**Kabbara et al.**, "A stereo

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vision based mixed reality system with natural feature point tracking”, Nara Institute of Science and technology, March 2001).

Additional state of the art reviewed and considered by the Examiner is found in Izquierdo et al., “Modeling arbitrary objects based on geometric surface conformity”, IEEE, 1999; Lin, C., “Invariants of three-dimensional contours”, IEEE, 1988; Kobbelt et al., “Feature sensitive surface extraction from volume data”, ACM, 2001; Blanz et al., “A morphable model for the synthesis of 3D faces”, ACM 1999.

None of these references taken either alone or in combination with the prior art of record discloses a method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, specifically including:

(Claim 8) “from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features”.

None of these references taken either alone or in combination with the prior art of record discloses a method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, specifically including:

(Claim 9) “from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of uniqueness of each of the identified features”.

None of these references taken either alone or in combination with the prior art of record discloses a method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, specifically including:

(Claim 11) “from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features”.

None of these references taken either alone or in combination with the prior art of record discloses a method in a computing system for determining 3-dimensional location and orientation of a subject surface in a distinguished perspective image of the subject surface, specifically including:

(Claim 28) “identifying a plurality of subsets of innate visual features of the subject surface, each subset containing visual features of a different general size;

based on an earlier-determined 3-dimensional location of the subject surface, selecting one subset of visual features;

using locations of the visual features of the selected subset in a perspective image of the subject surface that precedes the distinguished perspective image in time, and identifying search zones in the distinguished perspective image”.

None of these references taken either alone or in combination with the prior art of record discloses a computer-readable storage medium comprising computer executable

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instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, specifically including:

(Claim 32) “from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features”.

None of these references taken either alone or in combination with the prior art of record discloses a computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, specifically including:

(Claim 33) “from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of uniqueness of each of the identified features”.

None of these references taken either alone or in combination with the prior art of record discloses a computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, specifically including:

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(Claim 34) “from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features”.

None of these references taken either alone or in combination with the prior art of record discloses a computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for determining 3-dimensional location and orientation of a subject surface in a distinguished perspective image of the subject surface, specifically including:

(Claim 35) “identifying a plurality of subsets of innate visual features of the subject surface, each subset containing visual features of a different general size;

based on an earlier-determined 3-dimensional location of the subject surface, selecting one subset of visual features;

using locations of the visual features of the selected subset in a perspective image of the subject surface that precedes the distinguished perspective image in time, and identifying search zones in the distinguished perspective image”.

8. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance.”

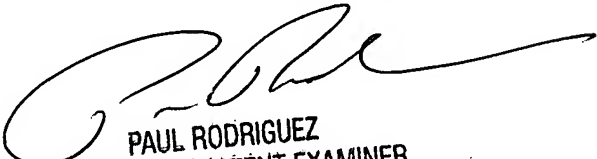
9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 571-272-3717. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Rodriguez, can be reached on 571-272-3753. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to TC 2100 Group receptionist: 571-272-2100.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

K. Thangavelu
Art Unit 2123
April 25, 2007



PAUL RODRIGUEZ
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2100

Clean copy of Allowed Claims

2. The method of claim 8 wherein the identification of the 2-dimensional positions at which the selected features occur in the image is predicated on an assumption that the selected features appear as coplanar in the image.

3. The method of claim 8 wherein the surface is a 2-dimensional surface.

4. The method of claim 8 wherein the surface is a flat surface.

5. The method of claim 8 wherein the surface is an irregular body that appears flat when observed at a distance.

6. Canceled.

7. The method of claim 8, further comprising using the determined location and orientation of the surface to superimpose a view of a 3-dimensional object over the surface.

8. A method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

9. A method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of uniqueness of each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

10. The method of claim 11 wherein the selection of visual features is performed based upon a comparison of levels of accuracy with which they can be used to determine the location and the orientation of the surface.

11. A method in a computing system for tracking movement of a surface having an arbitrary appearance relative to a camera, comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera,

wherein the selection of visual features includes selecting visual features in at least two different size ranges, the method further comprising selecting one of the size ranges based upon a measure of a distance to the surface's present location, and

wherein the selected features in the selected size range are used to determine the location and the orientation of the surface;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

12. The method of claim 9, further comprising, for each image of the sequence:
based upon the 2-dimensional positions at which the features are identified in one or more prior images of the sequence, predicting 2-dimensional positions at which the features will occur in the current image; and
establishing search zones about the predicted positions, and wherein identifying the 2-dimensional positions at which the selected features occur in the image comprises searching the established search zones for the selected features.

13. The method of claim 9 wherein the surface, in addition to having an arbitrary appearance, is modified to contain one or more fiducial markers,
the method further comprising, in a first image of the sequence, identifying and analyzing a portion of the image corresponding to the fiducial markers for determining the 3-dimensional location and orientation of the surface in the image, and wherein the determining the 3-dimensional location and orientation of the surface in the first image of the sequence is used to identify the 2-dimensional positions at which the selected features occur in the first image of the sequence.

14. The method of claim 13 wherein each fiducial marker comprises a unique distinguishing pattern.

15. The method of claim 13 wherein each fiducial marker is square-shaped.

16. The method of claim 9 wherein the 3-dimensional location and orientation of the surface in the image of the sequence is determined without use of explicit fiducial markers.

17. The method of claim 9 further comprising capturing the sequence of images using the camera, and wherein the determination is made in real-time with respect to the capture.

18. The method of claim 9 wherein the movement of the surface is tracked within an environment, and wherein, between two successive images of the sequence, the camera moves relative to the environment.

19. The method of claim 9 wherein the movement of the surface is tracked within an environment, and wherein, between two successive images of the sequence, the surface moves relative to the environment.

27. The method of claim 28 wherein the selected innate visual features of the subject surface number at least four.

28. A method in a computing system for determining 3-dimensional location and orientation of a subject surface in a distinguished perspective image of the subject surface, the subject surface having innate visual features, comprising:

identifying a plurality of subsets of innate visual features of the subject surface, each subset containing visual features of a different general size;

based on an earlier-determined 3-dimensional location of the subject surface, selecting one subset of visual features;

using locations of the visual features of the selected subset in a perspective image of the subject surface that precedes the distinguished perspective image in time, and identifying search zones in the distinguished perspective image;

searching the identified search zones for the visual features of the selected subset to determine 2-dimensional positions at which the visual features of the selected subset occur;

based on the determined 2-dimensional positions, determining the 3-dimensional location and orientation of a subject surface in the distinguished perspective image;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

29. The method of claim 28 wherein the determination of the 2-dimensional locations at which the selected visual features occur is predicated on an assumption that the selected visual features appear as coplanar in the image.

32. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, the method comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

33. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, the method comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of uniqueness of each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

34. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for tracking movement of a surface having an arbitrary appearance relative to a camera, the method comprising:

capturing an image of the surface using the camera;

analyzing the captured image of the surface to identify visual features present in the captured image;

from the identified visual features, selecting a plurality of visual features for use in tracking the movement of the surface, wherein the selection of visual features is performed based upon a comparison of levels of contrast provided by each of the identified features;

receiving a sequence of images captured by the camera, at least some of which constitute a view of at least a portion of the surface;

for each image of the sequence:

identifying 2-dimensional positions at which the selected features occur in the image; and

based upon the 2-dimensional positions at which the selected features are identified in the image, determining 3-dimensional location and orientation of the surface in the image of the sequence with respect to the camera,

wherein the selection of visual features includes selecting visual features in at least two different size ranges, the method further comprising selecting one of the size ranges based upon a measure of a distance to the surface's present location, and

wherein the selected features in the selected size range are used to determine the location and the orientation of the surface;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.

35. A computer-readable storage medium comprising computer executable instructions which when executed on a computing system cause the computing system to perform a method for determining 3-dimensional location and orientation of a subject surface in a distinguished perspective image of the subject surface, the subject surface having innate visual features, comprising:

identifying a plurality of subsets of innate visual features of the subject surface, each subset containing visual features of a different general size;

based on an earlier-determined 3-dimensional location of the subject surface, selecting one subset of visual features;

using locations of the visual features of the selected subset in a perspective image of the subject surface that precedes the distinguished perspective image in time, and identifying search zones in the distinguished perspective image;

searching the identified search zones for the visual features of the selected subset to determine 2-dimensional positions at which the visual features of the selected subset occur;

based on the determined 2-dimensional positions, determining the 3-dimensional location and orientation of a subject surface in the distinguished perspective image;

using the determined location and orientation of the surface to introduce a supplemental image into the images of the sequence at a size, location, and orientation that are relative to those of the surface to obtain an augmented sequence of images; and

displaying the augmented sequence of images using a computer display.